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Inland Waters Directorate
Western and Northern Region

Direction générale des eaux intérieures
Région de l'ouest et du nord

1991

ANNUAL REPORT

MACKENZIE RIVER

WATER LEVEL FORECAST

Prepared

For

The 1992 Western Arctic Athabasca-Mackenzie Workshop
Vancouver, British Columbia
January 14, 1992

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Executive Summary

The 1991 Mackenzie River Stage Forecast was initiated on May 21, 1991 and terminated on October 23, 1991, during which time it was distributed to 12 users. Generally all program objectives were met, as indicated by the results of a User Survey conducted after the close of the Navigation Season.

Water levels along the Mackenzie and Liard rivers were above the average seen in previous years for the entire season. Two high water events occurred, both of a moderate size.

Major improvements included the conversion of the distribution system from Telex to FAX, and the partial automation of the forecast procedures to improve forecast efficiency and reduce program costs. As well, a flow-routing model was developed and tested to improve the accuracy of the forecast, particularly during periods of rising water levels.

Acknowledgement

The Mackenzie Stage Forecast is a product of many people, and we would like to acknowledge their individual commitments which allowed the daily report to be transmitted before it's 08:30 deadline each morning. Of special note are the Water Survey of Canada staff in Inuvik, Fort Simpson and Fort Smith who build and service the hydrometric stations that provide the real time data; the forecasters in Yellowknife who process this data and prepare the daily reports while implementing new and more efficient methods; and the observers in Fort Liard and Fort Good Hope who report the water levels before 07:30 each day, regardless of the weather, and still sound cheerful on the phone. A very special Thanks is extended to the staff in the Yellowknife office of the Atmospheric Environment Service who prepare the special forecast area Weather Summary, which has proven to be important no only to the Forecast preparation , but as a guide to many of the Forecast users.

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1.0 Introduction

The Mackenzie River Stage Forecast is a daily open water public report of the projected one, two and three day water level (or stage) at selected points along the Mackenzie River in the N.W.T. The report includes the current daily stage at Water Survey of Canada (WSC), Environment Canada, hydrometric station locations on the Mackenzie, Liard and Peel rivers, and a summary of weather conditions over the basin provided by the Yellowknife, N.W.T., office of the Atmospheric Environment Service (AES), Environment Canada. During periods of high stage, additional reports are prepared on an as-required basis, and summary plots of the daily stage at important points and ferry crossings are prepared and released on a weekly basis.

The primary focus of the Forecast is to allow for safe and economical barge transportation along the Mackenzie and Liard rivers. However, it is also used by public and private agencies for their operations along the waterways. During 1991 open water period the forecast was distributed daily by FAX to 12 users.

The Forecast is prepared and distributed by the Yellowknife office of Inland Waters Directorate (IWD), Environment Canada, under a cost shared agreement with the Canadian Coast Guard (CCG), Transport Canada, Hay River, N.W.T.

1.1 1991 Mackenzie Forecast

With the early breakup of the Mackenzie/Liard rivers this year, the Coast Guard requested that the forecast begin as soon as possible after May 15, 1991. This was three weeks earlier than normal. The first forecast report was issued on May 21st, and the final report was issued on October 23, a period of 162 days. In that time 117 daily reports were prepared, as well as three additional reports, during a high water period. Two daily reports were not issued due to operator error, and two reports were missed due to staff illness.

Reports were issued 7 days a week from May 21st to June 15th, and five days a week from that point on.

Several changes were made during 1991. The most important was the automation of daily procedures to speed up the preparation of the forecast. Next, a Mackenzie River Flow Routing Model, called SIMMAC, was developed, and a prototype is ready for operational testing. These are discussed in Sections 2.0.1 and 2.0.2.

The Public Service was on strike twice during the forecast season, from Sept. 9th to the 18th, and from Sept. 27th to Oct 2nd. Daily forecast reports were continued by a designated employee. However, the weekly stage plots prepared for the barge transportation companies and the ferry operators were suspended during the strike and were not resumed afterward as the season was nearly over.

Figures 1 and 2 show the Mackenzie River stage during the forecast period. From these plots three distinct periods of stage conditions can be identified:

a) From breakup to mid-July the water level remained high, due to the volume of runoff combined with frequent scattered precipitation throughout the basin, especially northern British Columbia. This can be seen in the lack of change of the stage at Fort Providence, which measures the contribution from Alberta and the central N.W.T.

b) On the 19th and 28th of July two heavy rainfall events occurred in the Mackenzie Mountains which caused the water levels to rise briefly along the river below Fort Simpson. These can be seen as sharp peaks on Figures 1 and 2. Note that the second peak is very small at Fort Simpson (Fig. 1), yet is as large as the first at Wrigley. This indicates the different paths of the two storms, the first crossing the central Mountains and the Liard basin, the second concentrated on the northern edges of the Mountains.

c) Following these two storms, the river receded quickly to expected seasonal levels during August, as precipitation generally declined. The river, however, remained at slightly above normal levels for the rest of the season.

1.2 Hydrometric Observation Network

The 1991 Mackenzie Stage Forecast began operating with seventeen hydrometric stations providing data of which ten were reported on the daily forecast. At the end of the season this had risen to nineteen data stations, with fifteen of these included on the daily report.

The two data stations added to the forecast were the Peel River above Fort MacPherson for ferry operations, and the Mackenzie River at Strong Point, a new WSC site.

All the stations used for the forecast except four are equipped with remote sensing and communication equipment which provides continuous real-time data collection via satellite. Of the four exceptions, two provide data by telephone (telemark), one has an observer, and one has both an observer and a telemark.

Eight additional sites were monitored daily to provide data for the development of the SIMMAC Flow Routing Model. All these sites use the satellite system.

The location of all these sites is illustrated in Figure 3, and a sample forecast report is included in Appendix A.

1.3 Forecast Users

Organizations who received the Forecast in 1991 are listed in Table 1, below.

Table 1 - List of Users

User Name	User Type	Stage Plot
1) Northern Transportation Co., Hay River	Barge Service	Stage
2) Northern Transportation Co., Norman Wells	Barge Service	Stage
3) Cooper's Barging, Fort Nelson	Barge Service	Stage
4) Arctic Transportation, Calgary *	Barge Service	--
5) Coast Guard, Hay River	Navigation Control	Both
6) Coast Guard Radio, Inuvik	Navigation Control	--
7) Esso Resources Ltd., Norman Wells	Resource Management	Stage
8) GNWT Marine Operations, Yellowknife	Ferry Operation	Ferry
9) GNWT Marine Operations, Fort Simpson	Ferry Operation	Ferry
10) GNWT Marine Operations, Inuvik	Ferry Operation	Ferry
11) Public Works Canada, Fort Simpson **	Project Management	Stage
12) Simpson Air, Fort Simpson **	Floatplane Operations	--
13) Wolverine Air, Fort Simpson **	Floatplane Operations	--
14) Water Survey Canada, Fort Simpson ***	Public Information	--
15) Water Survey Canada, Inuvik ***	Public Information	--

* - discontinued in 1991
** - new user in 1991
*** - not counted as users for this report

All daily reports and weekly stage plots were transmitted by FAX rather than Telex, which was discontinued in 1990. This led to a significant improvement in overall efficiency and a reduction in communication costs.

1.4 AES Weather Reports

A special Weather Summary for the Forecast area was prepared on a daily basis, seven days a week, by the Atmospheric Environment Service in Yellowknife, N.W.T. These reports include maps of existing frontal systems in the forecast area and rainfall for the previous day.

This service has proved invaluable in developing the Forecasts and the summaries are read extensively by the users.

1.5 1991 Program Costs

The IWD-NWT costs associated with the preparation and distribution of the Forecast are summarized as follows:

Table 2 - IWD-NWT Forecast Costs, 1991

SECTION	SALARY	OPERATIONAL	AIR CHARTER	TOTAL
WSC Fort Smith	500.00	1,940.00	--	2,440.00
WSC Fort Simpson	1,860.00	--	6,270.00	8,130.00
WSC Inuvik	4,280.00	1,820.00	13,650.00	19,750.00
Observers	--	3,150.00	__	3,150.00
Forecasting	16,227.67	__	__	16,227.67
Communications	--	2,060.00	__	2,060.00
sub-totals	$ 22,867.67	$ 8,970.00	$ 19,920.00	$ 51,757.67

Under the cost shared agreement with Transport Canada, $ 16,000.00 is provided to the Forecast by the Canadian Coast Guard. In addition, the Coast Guard provided some non-costed work-shared assistance to IWD-NWT.

An additional $ 29,200.00 was expended by IWD-NWT, mainly in staff time on the development and testing of the forecast automation and flow routing model.

The Atmospheric Environment Service provided their special Weather Summary at no cost.

2.0 New Initiatives in 1991

With the increasing importance the Mackenzie Stage Forecast for predictions of high water levels with greater accuracy; regular reporting of current water levels for safer river operations; the need to reduce overall forecasting costs, while maintaining a high level of stage prediction; and to continue to meet the requests of clients, the following projects were undertaken.

2.0.1 Automation of Forecast Procedures

Prior to 1991 all forecast operations were carried out using manual methods. Realtime data received from remote locations was edited on a computer screen and the latest data selected. These points were then plotted on a continuous stage graph sheet, and connected with the previous days points. Using the trends of the stage and the day's weather, the three forecast stations stage plots were extended and the predicted water levels for the next three days taken from this estimation line. These were then combined with the latest data and the weather summary on a report which was transmitted to the users.

During the winter and spring of 1991 computer programs were developed, tested and made operational (in July 1991), which automatically received, edited, checked and placed on worksheets the raw data from the Canadian ground receive sites. This was then plotted and checked by the forecaster, and updated if necessary. A second program took the updated data from the worksheet and placed it onto a report sheet, where the Weather summary was

added, and the forecast FAXed to the users.

A second additional program was developed to translate data received from the US ground receive site into the same format used by the Canadian files so this source of data could be automatically processed as well. This allowed effective backup in obtaining the daily data, and enhanced the flexibility of the forecast as this data could be obtained at short notice.

These new procedures have reduced the data processing and preparation time by about thirty (30) minutes a day.

The only remaining procedure from previous years is the hand-plotting of the daily stages, and estimation of the 3-day forecast.

2.0.2 Mackenzie River Flow-Routing Model

Historically the primary focus of the stage forecasts on the Mackenzie River was the prediction of low flow and stage at the various rapids along the river, so that barge transportation companies could pre-plan their loads so as to pass these points safely and in the minimum of time.

Since the water levels recede gradually, the trends can be predicted some time in advance as the water level recedes, and can be accurately estimated as a simple curve or even straight line plot by the Forecaster.

In recent years, however, more emphasis has been placed on monitoring the daily stage for ferry operations, and predicting the high water levels during and after floods, breakup and high water events such as rainstorms. Such events are controlled by the weather and may occur at any time and in several different ways. The simple system developed over previous years cannot completely fulfil these new demands.

Thus in early 1991 several computerized flow-routing techniques were investigated, from a simple spreadsheet to complex hydraulic modelling. A modification of the US Army Corps of Engineers SSARR program, called SIMMAC (for SIMulated MACkenzie) was developed by Studies and Hydrology, IWD-NWT.

Using the already developed automatic methods for data retrieval outlined in Section 2.0.1, the SIMMAC program takes the various data inputs as water levels and converts them to flows. These flows are routed through the computer model simulating the distance and elapsed time required (such as 1, 2 or 3 days). The resulting numbers, representing the predicted flows, are then

converted back to water levels at selected sites. These predictions are then reviewed and if accepted, placed on the report for distribution to the users.

The SIMMAC model was tested in August, 1991 and operational modifications were made during September and October 1991. Further testing was interrupted by the PSAC Strikes.

2.0.3 Weekly Stage Plots

During the Forecast season summary plots of the water level at selected locations along the Mackenzie River were prepared weekly and distributed by FAX to interested users. Initially these plots included the three forecast locations at Norman Wells, Sans Sault and Fort Good Hope as well as the Liard River at the Mouth and the Mackenzie at Fort Simpson.

At the request of the Government of the NWT, Marine Operations, a second graph was produced from August 1st which included the stations associated with ferry locations, ie, the Mackenzie River at Fort Providence, the Liard River at the Mouth, the Mackenzie River at Arctic Red River and the Peel River at Fort McPherson, as well as the Mackenzie at Fort Simpson.

These stage plots were issued from May 21st until August 30th and were well received by the users. They were discontinued early due to workload during the PSAC Strike, as mentioned in Section 1.1.

Examples of both stage plots are included in Appendix A.

2.0.4 User Survey

With increasing resource commitments required of IWD-NWT to produce the forecast, a survey was conducted at the end of the season to assess the value to the users. A two page questionnaire was sent to the users on November 26, 1991 by FAX. Seven replies were received.

A copy of the questionnaire with summaries of the answers is included as Appendix B.

General conclusions indicate that:

- the users are satisfied with the information received on the daily forecast.
- the service is used in the planning and management of a wide variety of operations centring around the Mackenzie/Liard rivers.
- the weekly stage plots are of great use and should be continued. Inclusion of other information, such as forecast stage, would be useful.
- the AES Weather Summary is widely read by users, especially those who do not receive other regular weather reports.

A detailed assessment of the questionnaire will be carried out and the results applied to the 1992 operations wherever feasible

2.1 Accuracy of the Forecast

To assess the accuracy of the 1991 forecast it was decided to examine a single station in detail. The station selected was the Mackenzie River at Sans Sault Rapids (WSC station 10KD001).

This site is a remote station located on the right bank of the Mackenzie River below the Sans Sault Rapids, one of a series of rapids which restrict barge transportation along the Mackenzie River. This is the reason for the stations existence.

The site was established in 1968 by the late Herb Wood, and was one of the first sites in Canada to receive satellite transmission equipment. It consists of an instrument shelter which houses a servo-manometer and recorder to measure the river stage, and a Data Collection Platform (DCP) to store and transmit the hourly stage to ground stations via satellite. The site is serviced by IWD WSC staff from Inuvik via their seasonal office in Norman Wells.

The station was activated for the 1991 season on May 29th, and first appeared on the May 30th forecast report. No trouble was experienced with the data reception from the site through the season, but a slight problem was encountered with the Telemark (the device which records the stage) which was giving a random 2 metre error. Until it was fixed in late June stage reports from this site were carefully checked for these errors and corrected if necessary prior to distribution.

The quality of data collected from this site were considered very good

throughout the season, and much of the credit for this goes to Moe Hanson and his staff in Inuvik. Figure 4 is a plot of the recorded stage with the 3-day forecast super-imposed on it. Note the spike in the forecast near the end of the season which was an error by the forecaster when reading the seasonal stage plot. Also of interest is the plot of the forecast high water event for the July 19th rainfall, compared to the actual stage (point A on plot). It was well under the recorded water level.

To illustrate the accuracy of the forecast predictions in 1991 plots of the predicted versus the recorded stage for the 1-day, 2-day and 3-day forecasts were developed, Figures 5, 6 and 7 respectively.

A simple 1:1 line is used as a reference which represents an accurate prediction. If the forecasted stage was lower than the actual stage which occurred, the point plotted on the graph will be below this reference line, similarly if the forecast was high, the point will be plotted above the line.

As can be seen from these plots, the scatter of the predicted points about the reference line increases the farther we move in time from our known stage, as we would expect. Generally, the predictions are close below 6 metres. Above this point the predictions scatter out as the stage increases, tending toward the high side.

Relating the forecast stages in Figure 4 to the plot of the same points in Figure 7, the error which occurred in October plots as an extreme high at the lower end of the graph, while the low predictions of stage during the July 19th rainfall event plot well below the reference line. The other points in this region are above the reference line.

From these plots we can conclude the following:

a) During periods of rising stage the forecast water levels are less accurate (.2 to .5 metres), and the forecasters tend to predict higher than the actual stage will be.

b) When the stage is receding the forecast stages are more accurately predicted, and the trend is to predict slightly low.

The bias of the forecaster to predict high when the stage is rising and low when it is falling is understandable. It reflects the different importance of high and low water levels under different conditions, and the desire of the forecaster not to underestimate either.

These conclusions can be generally applied to the other two forecast locations located at Norman Wells and Sans Sault.

3.0 Proposed Improvements for the 1992 Navigation Season

The following are recommended for implementation during the 1992 navigation season to improve the accuracy of the forecast and reduce overall resource requirements (human and financial) associated with the production and distribution.

1) That the automated computer system for the receipt, processing, preparation and distribution of the daily forecast continue to be developed and refined. This should include the installation and operation of direct satellite receiving equipment in IWD's Yellowknife office and the installation of a FAX Modem board in the Forecast computer to allow the receipt and distribution of reports without interruption by other office business.

2) The computer based flow-routing model is to be developed and made fully operational with the primary objectives to attain greater accuracy in high and rising water conditions, and improve overall operational efficiency.

With increasing demands being placed on IWD-NWT resources for the development and production of the Mackenzie River Stage Forecasts, new work shared/cost shared arrangements with Transport Canada and the other users groups will have to be explored and implemented, if this service is to continue in the future.

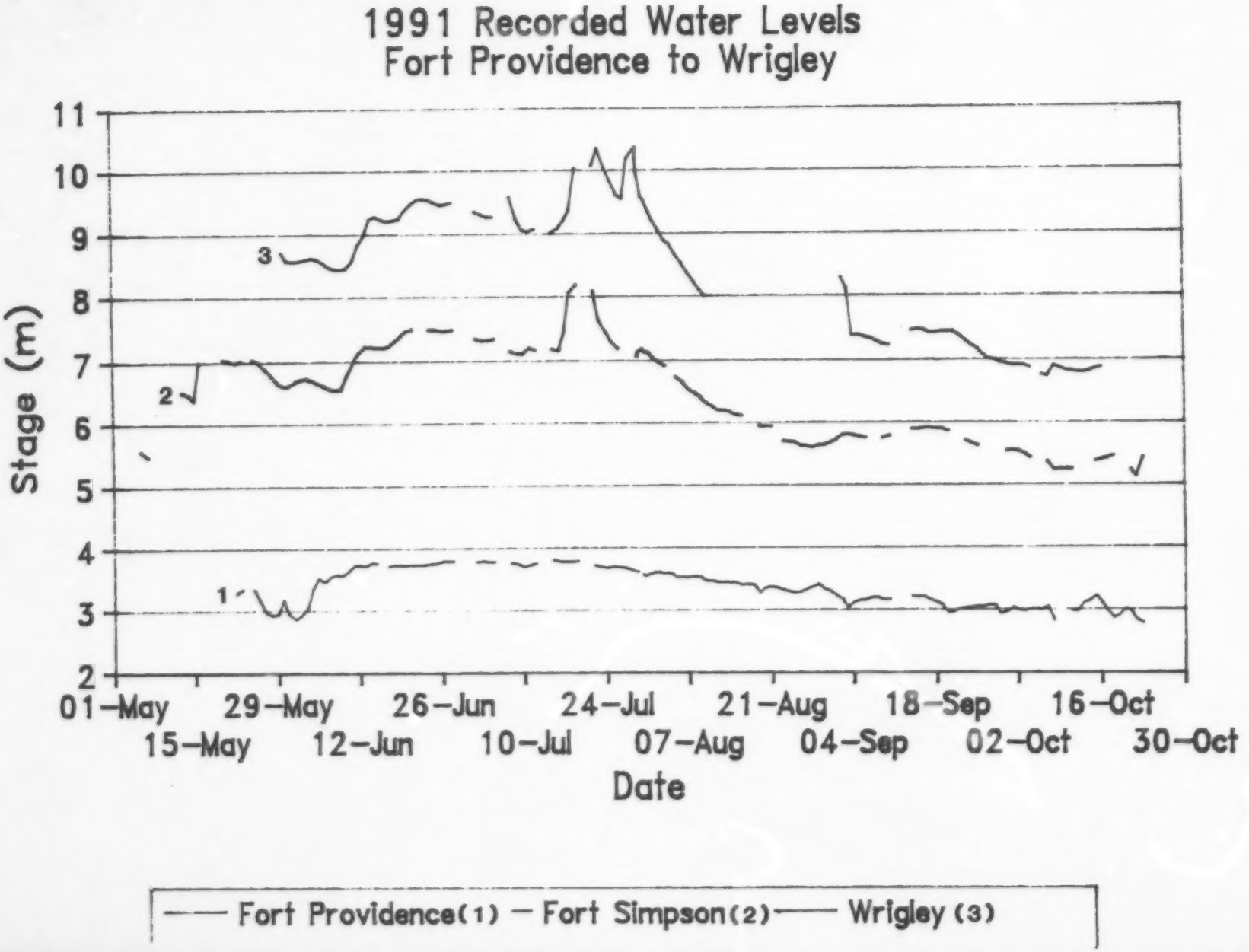

1991 Recorded Water Levels
Fort Providence to Wrigley
Stage (m)
11
10
9
8
7
6
5
4
3
2
01-May
15-May
29-May
12-Jun
26-Jun
10-Jul
24-Jul
07-Aug
21-Aug
04-Sep
18-Sep
02-Oct
16-Oct
30-Oct
Date
1
2
3
Fort Providence(1)
Fort Simpson(2)
Wrigley (3)

Figure 1

1991 Recorded Water Levels
Norman Wells to Arctic Red River

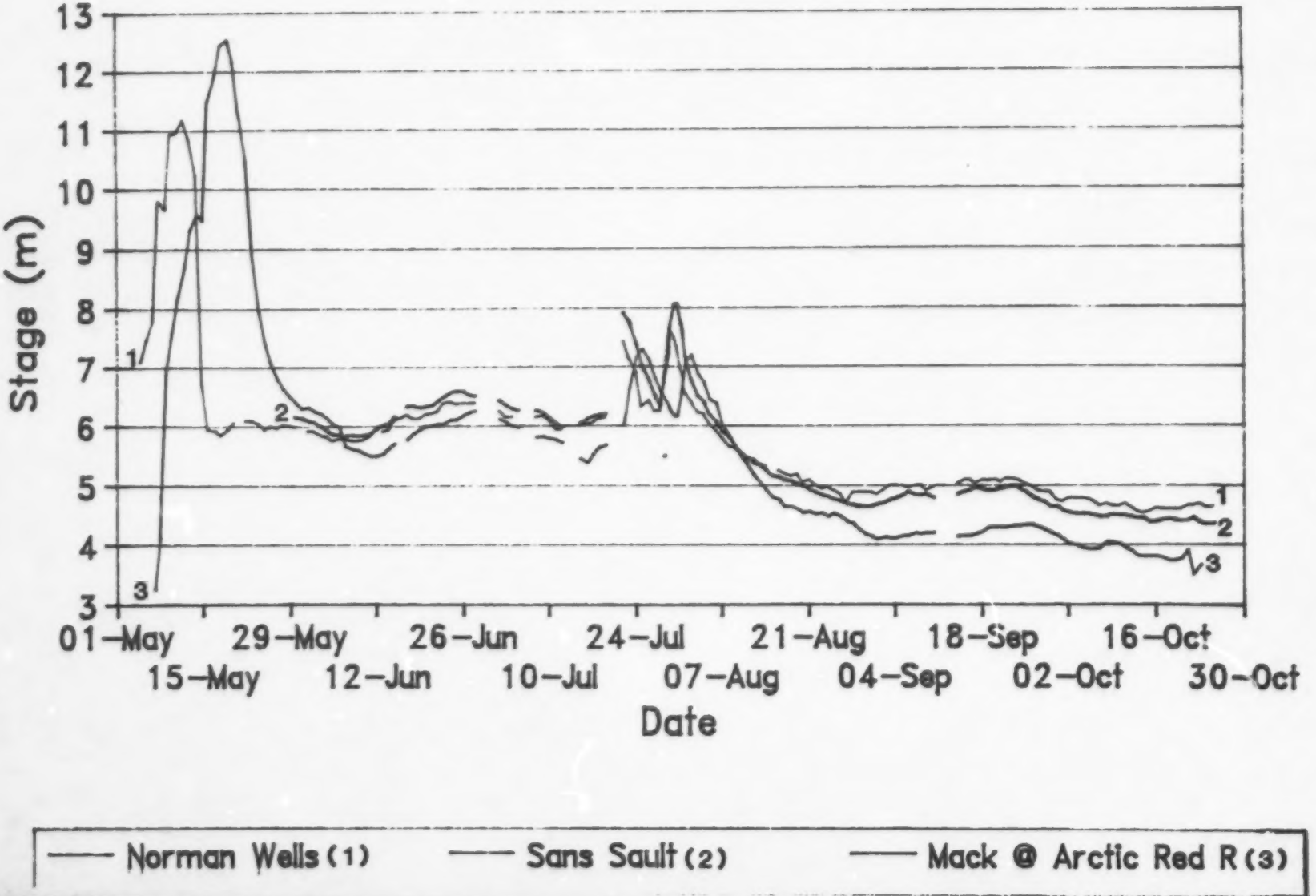


Figure 2

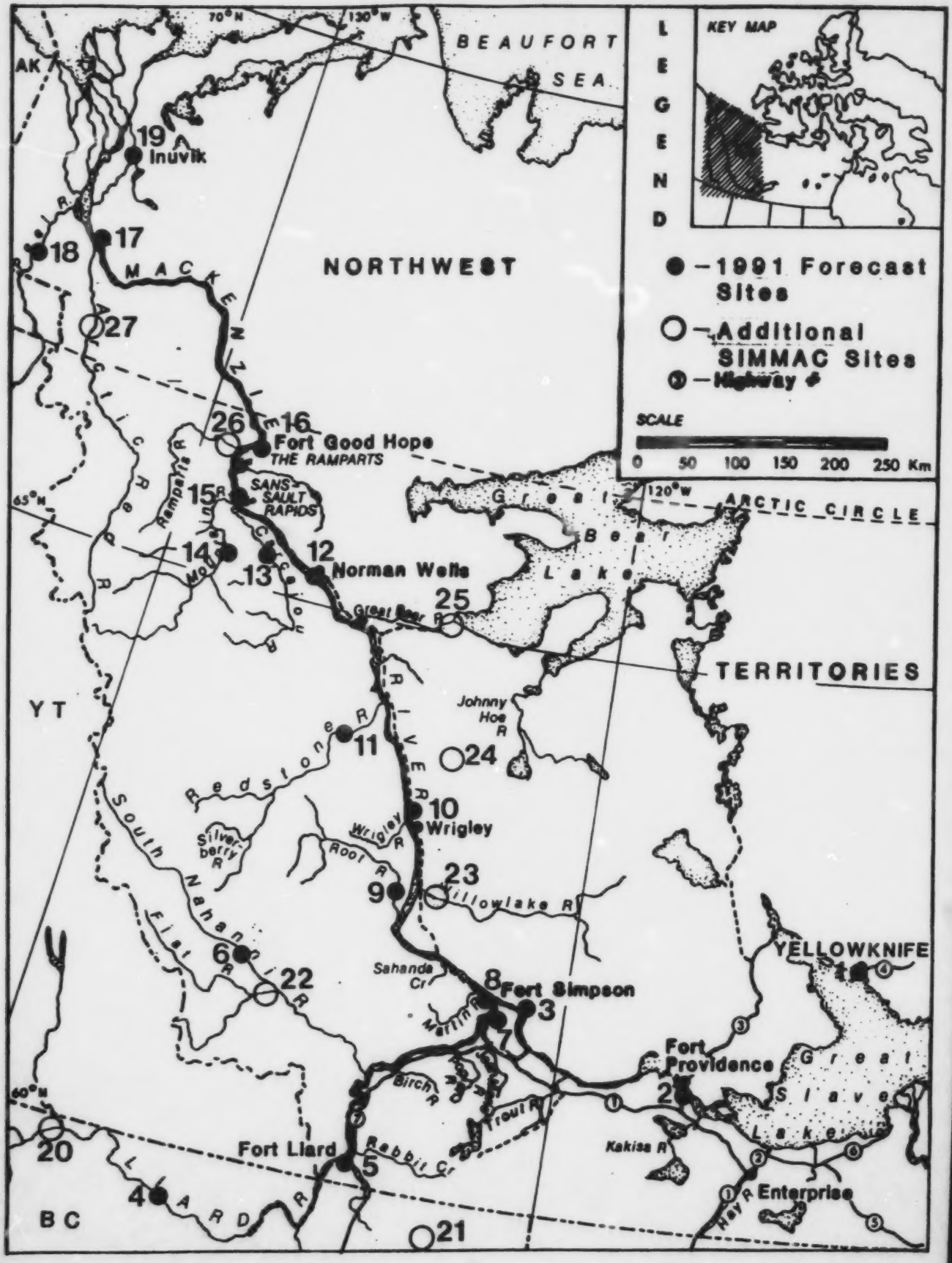


Figure 3 - 1991 Mackenzie Forecast Station Location Map

Figure 3 - 1991 Mackenzie Stage Forecast Station List

STATION	TYPE OF TRANSMISSION	WSC OFFICE RESPONSIBLE
Above Mackenzie/Liard Confluence		
1 Great Slave Lake at Yellowknife Bay *	Tel	Yellowknife
2 Mackenzie River near Fort Providence	Sat	Ft Smith
3 Mackenzie River at Strong Point **	Sat	Ft Simpson
Liard Basin		
4 Liard River at Lower Crossing	Sat	BC
5 Liard River at Fort Liard	Obs/Tel	Ft Simpson
6 South Nahanni River above Virginia Falls	Sat	Ft Simpson
7 Liard River near the Mouth	Sat	Ft Simpson
Below Mackenzie/Liard Confluence		
8 Mackenzie River at Fort Simpson	Tel	Ft Simpson
9 Root River near the Mouth	Sat	Ft Simpson
10 Mackenzie River near Wrigley	Sat	Ft Simpson
11 Redstone River 63 km above Mouth	Sat	Inuvik
12 Mackenzie River at Norman Wells	Sat	Inuvik
13 Carcajou River below Imperial River	Sat	Inuvik
14 Mountain River below Cambrian Creek	Sat	Inuvik
15 Mackenzie River at Sans Sault Rapids	Sat	Inuvik
16 Mackenzie River at Fort Good Hope	Obs	Inuvik
17 Mackenzie River at Arctic Red River	Sat	Inuvik
18 Peel River above Fort McPherson	Sat	Inuvik
19 Mackenzie River (E. Ch.) at Inuvik	Sat	Inuvik
Additional SIMMAC Sites		
20 Dease River near the Mouth	Sat	Yukon
21 Fontas River near the Mouth	Sat	BC
22 Flat River near the Mouth	Sat	Ft Simpson
23 Willowlake River above Methadali Creek	Sat	Ft Simpson
24 Blackwater River at Outlet of Blackwater Lake	Sat	Ft Simpson
25 Great Bear River at Outlet of Great Bear Lake	Sat	Inuvik
26 Ramparts River near Fort Good Hope	Sat	Inuvik
27 Arctic Red River near the Mouth	Sat	Inuvik

Obs - IWD Observer Tel - telemark system
Sat - Satellite Transmitter
* - Station updated once a week ** - newly built station

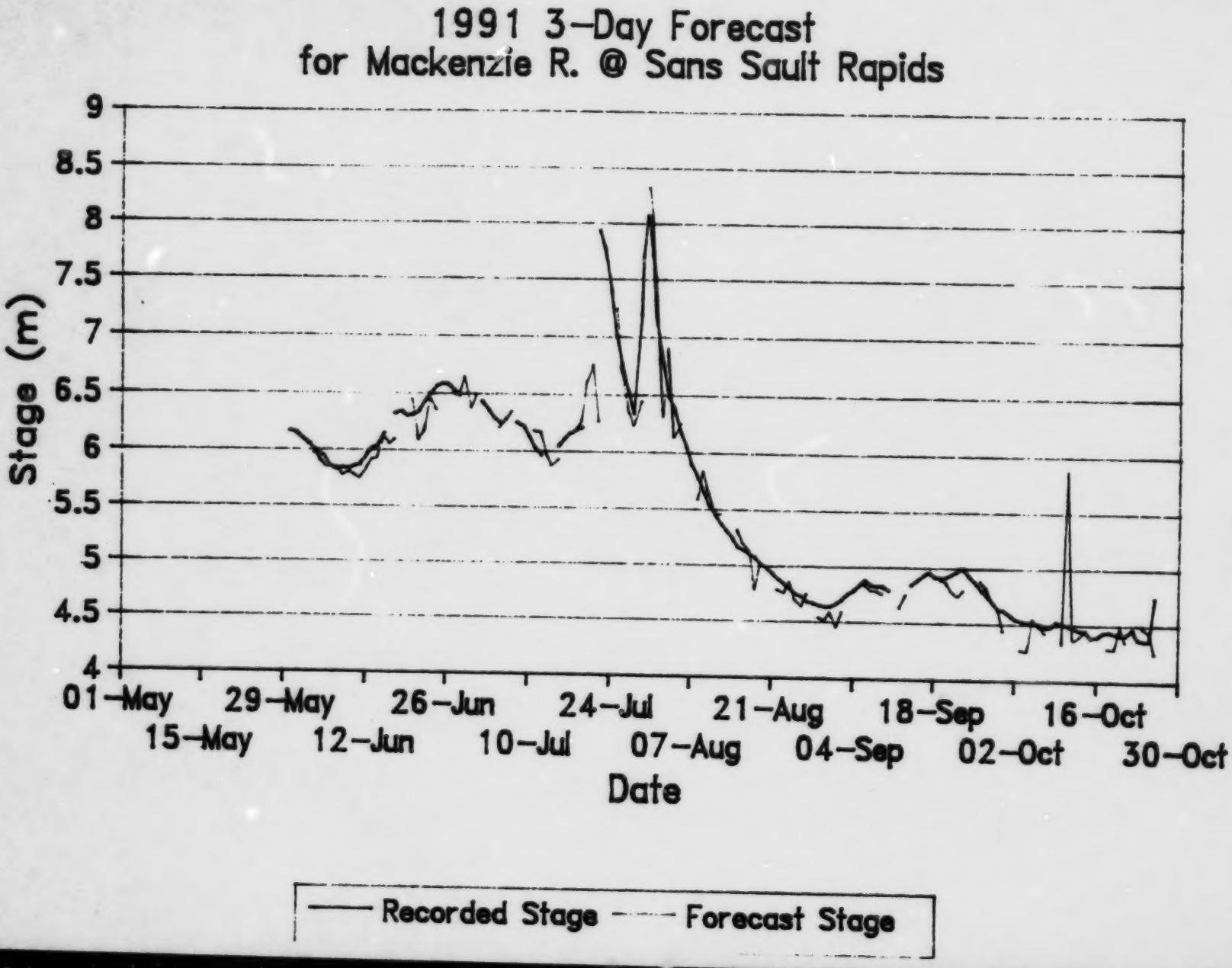


Figure 4 - 1991 Stage at Sans Sault

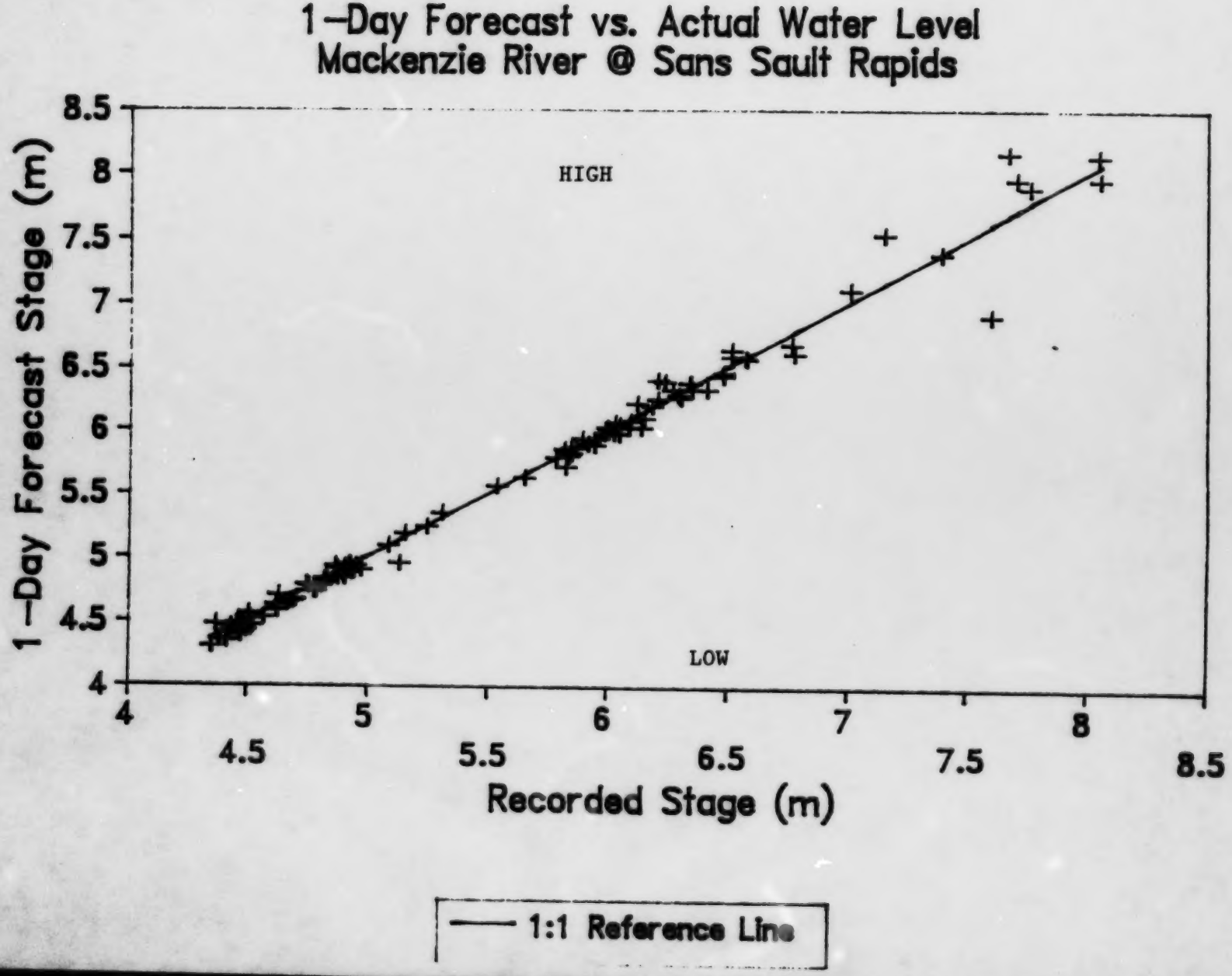


Figure 5 - 1-Day Reference Plot

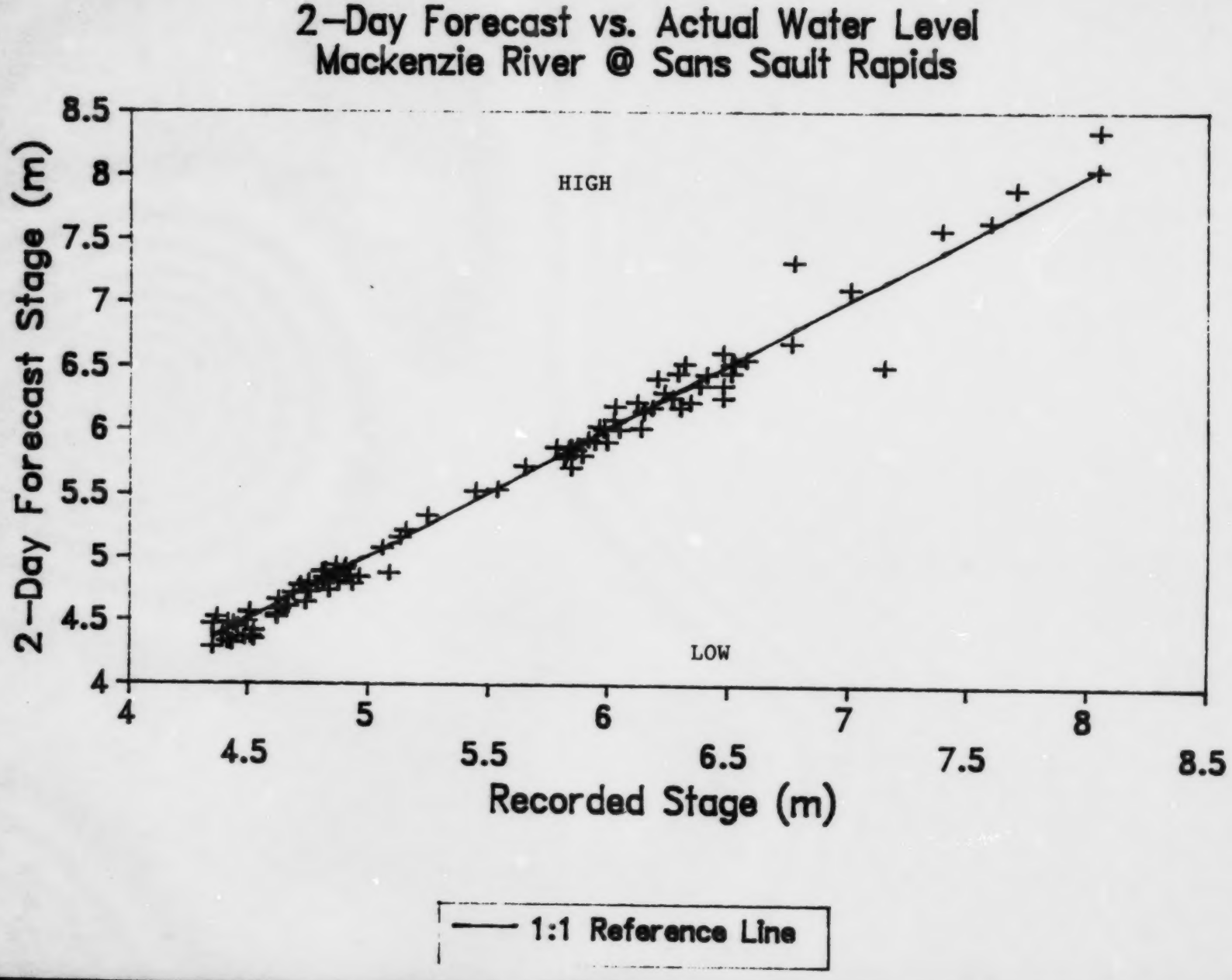


Figure 6 - 2-Day Reference Plot

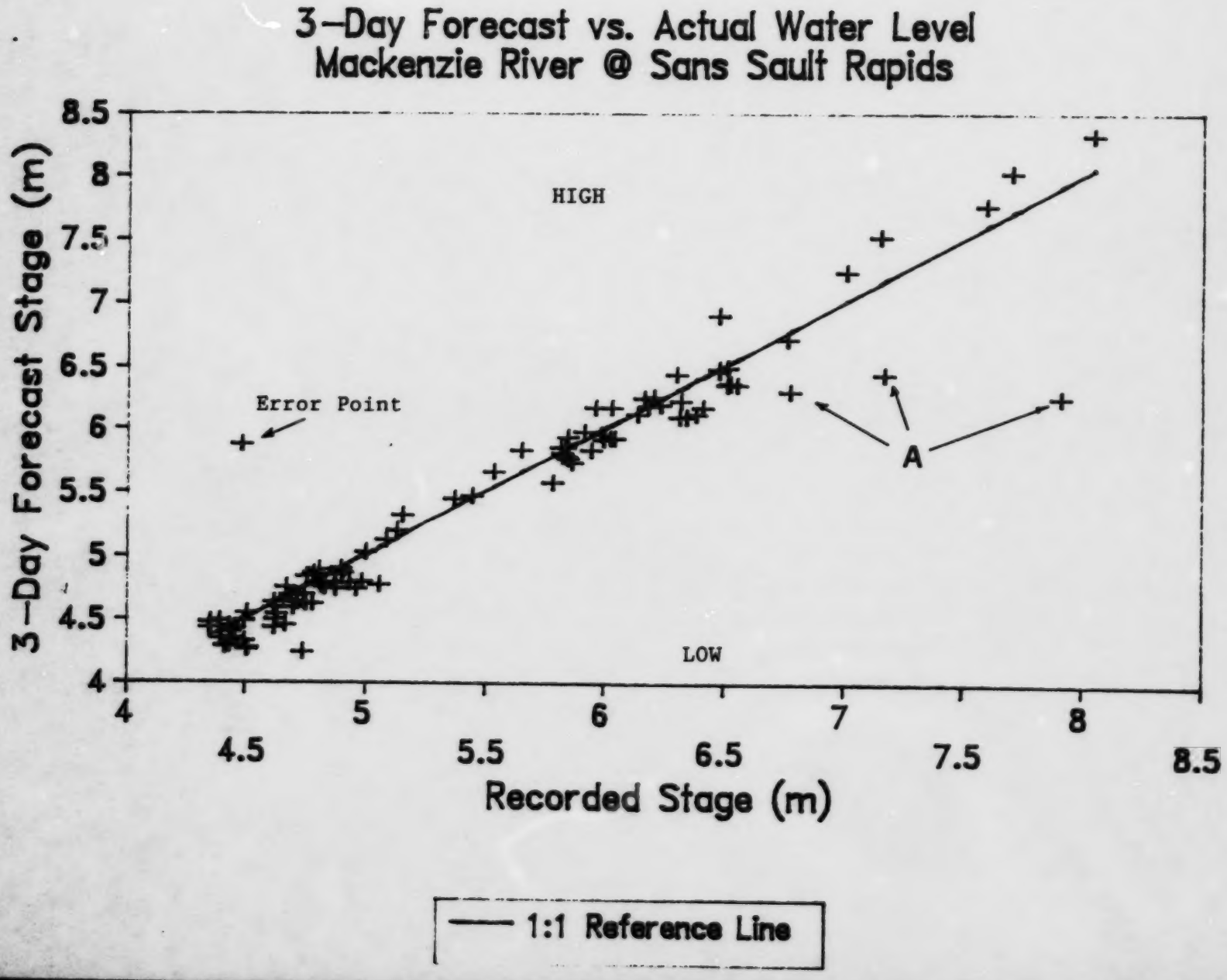


Figure 7 - 3-Day Reference Plot

Appendix A - Sample Forecast Report and Stage Plots

ENVIRONMENT CANADA, INLAND WATERS DIRECTORATE, NWT PROGRAMS
1991 MACKENZIE RIVER WATER LEVEL FORECAST

Date: Aug 9/91 Time: 08:00 Forecaster: PSq Report No. 68

1. WATER LEVELS - Levels in metres above WSC gauge datum except for Great Slave Lake in metres above sea level (ASL).

Location	OBSERVED Date	Time (MDST)	Level (m)
Great Slave L/YK	Aug 5	10:00	156.974
Mack/Fort Providence	Aug 9	04:36	3.516
Mack/Fort Simpson	Aug 9	07:45	6.39
Mack/Wrigley	Aug 9	06:42	8.090
Mack/Norman Wells	Aug 9	06:46	5.619
Mack/Sans Sault	Aug 9	06:26	5.653
Mack/Fort Good Hope	Aug 9	07:20	4.448
Mack/Arctic Red R	Aug 9	04:40	5.658
Mack/E Ch/Inuvik	Aug 9	05:54	2.701

Liard/Fort Liard	Aug 9	07:45	4.143
S Nahanni/Virg Falls	Aug 9	06:41	2.654
Liard/Near Mouth	Aug 9	04:49	3.699
Root River	Aug 9	05:39	3.023
Peel/Fort McPherson	Aug 9	04:43	6.251

2. FORECAST WATER LEVELS - Mackenzie River.

Date	Norman Wells	Sans Sault	Fort Good Hope
Aug 10	5.54	5.57	4.30
Aug 11	5.44	5.52	4.17
Aug 12	5.38	5.45	4.08

3. WEATHER SUMMARY ISSUED BY AES YELLOWKNIFE AT 06:00 MDT, AUG 9/91

A maritime cold front in vicinity Fort Simpson will be moving northeastward today. Along and behind the front cloudy skies and showers are expected today and tomorrow. Tempeartures will also cool down a few degrees after the front passes. To the north an arctic front in the Delta area will give much cooler temperatures to the Inuvik and surrounding areas for the next couple days. Clouds and precipitation are also expected.

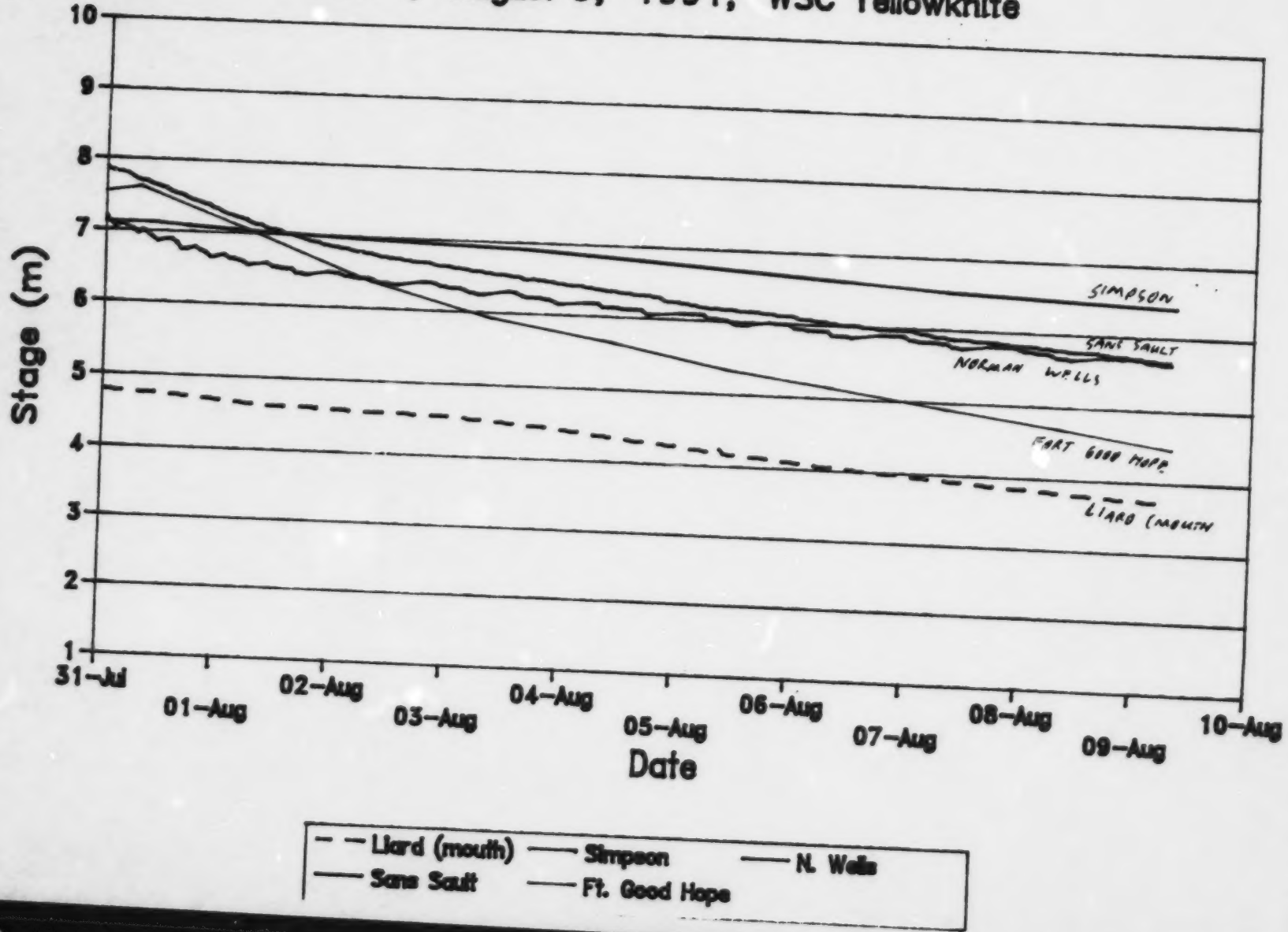
4. COMMENTS

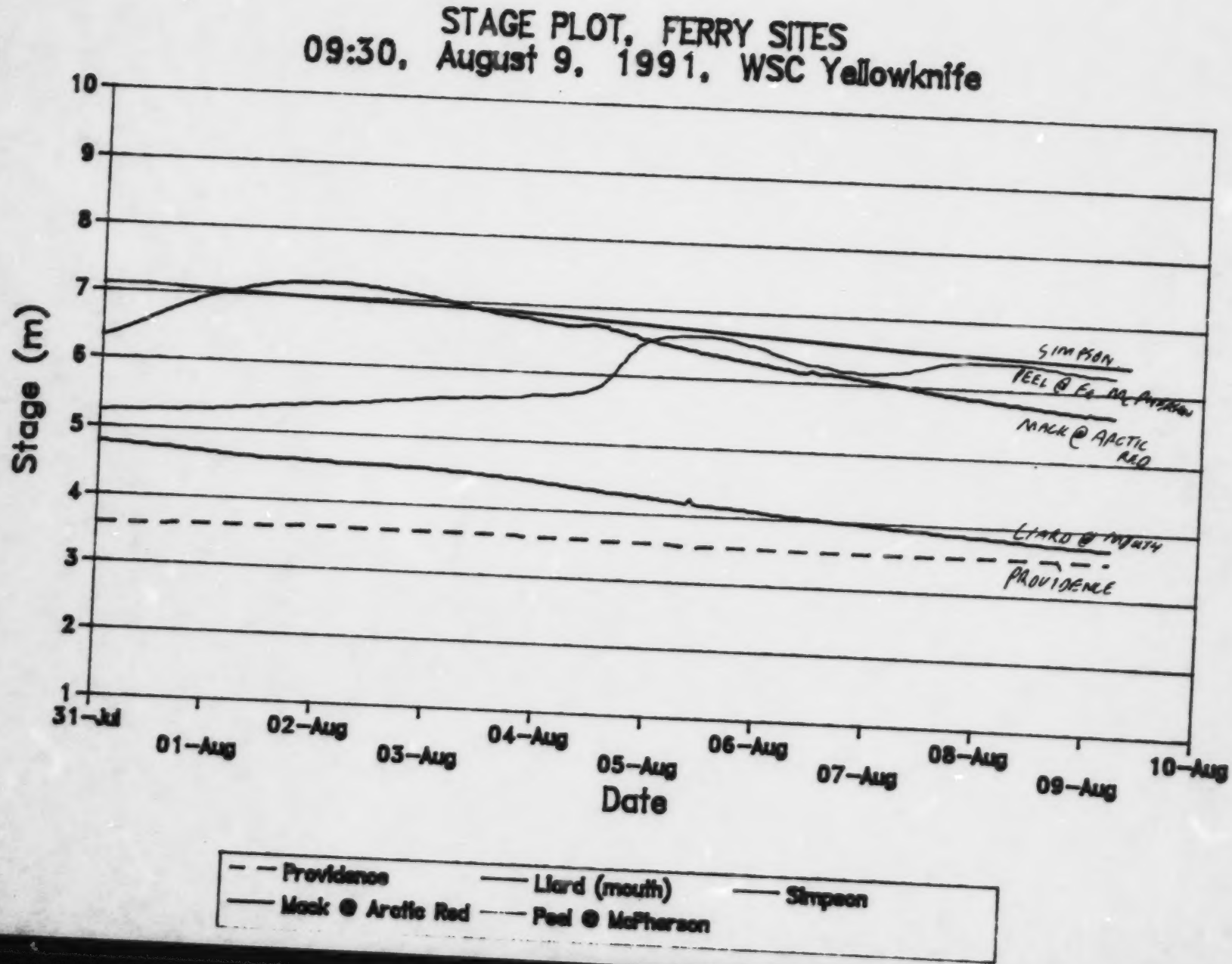
Stage along the Mackenzie and Liard rivers remains at near seasonal levels. No unexpected rise in stage foreseen next 24 hours.

5. CONTACTS

Additional Info: Paul Squires, (403) 920-8512, Fax (403) 873-6776
Chief, NWT Programs, YK, NWT (403) 920-8500

MACKENZIE RIVER STAGE PLOT
09:11, August 9, 1991, WSC Yellowknife




STAGE PLOT, FERRY SITES
09:30, August 9, 1991, WSC Yellowknife
Stage (m)
10
9
8
7
6
5
4
3
2
1
31-Jul
01-Aug
02-Aug
03-Aug
04-Aug
05-Aug
06-Aug
07-Aug
08-Aug
09-Aug
10-Aug
Date
SIMPSON
PEEL @ Fo
MACK @ ARCTIC RED
LIARD @ MOUTH
PROVIDENCE
Providence
Liard (mouth)
Simpson
Mack @ Arctic Red
Peel @ McPherson

Appendix B - 1991 User Survey Summary

1991 MACKENZIE RIVER STAGE FORECAST - USERS SURVEY

This years report on the 1991 Forecast season will look at the quality and importance of the service provided. To help get some accurate information on this subject we have prepared the following questionaire. We would greatly appreciate it if you could send copies to those who use the forecast during the shipping season, in any way, and ask them to complete one.

Information gathered will be used for only the 1991 Forecast Report. Sources will not be identified without their permission.

Please return the completed questionaire to Paul Squires, IWD Yellowknife, Box 2970, Yellowknife, N.W.T., X1A 2R2, or FAX it to (403) 873-6776. We Thank You for your assistance.

TOTAL RESPONSES - 7 (4 site specific, 2 concerned with whole river, 1 on different sites depending on on circumstance; 3 private, 4 government)

BACKGROUND INFORMATION

1. What is the main occupation of your company or department?

2☐ Water Transportation	1☐ Air Transportation
2☐ Water Navigation	1☐ Oil & Gas
3☐ Ferry Operations	_☐ Placer Mining
1☐ Construction or Maintenence	_☐ Public Distribution of Information
	_☐ Other _____

2. Is your main focus of interest...

4☐ High Stage	3☐ Low Stage
6☐ Changes in Stage	1☐ Other Debris & Driftwood reporting.

3. Do you...

3☐ Use the information yourself?
4☐ Use the information in your company or department only?
3☐ Pass the information along to people outside your company or department?

4. If you pass the information to others, is it edited?

2☐ Yes 5☐ No

5. How can we improve the forecast for your particular application?

- diect hookup into local DCP with high stage alarm (already planned).
- put forecast stage onto graph plots.
- better forecasting on upper Peel River.
- year-round reporting od Mackenzie at Fort Providence.

STAGE REPORTS

6. Do you find that the reported stages and forecasts accurately portray the conditions in the basin?

3☐ Very Close	4☐ Usually Close	_☐ Occasionally Close	_☐ Seldom Close

7. Do you use the Stage Forecasts for Norman Wells, Sans Sault and Fort Good Hope?

3☐ Yes 3☐ No 1☐ Sometimes

8. If so, how much use are they?

2☐ Very Useful _☐ Usually Useful 2*☐ Occasionally Useful _☐ Seldom Useful

* one user only uses 1 site, rates it very useful.

9. Again, if you use the Forecast, which day is the most useful?

1☐ 1 Day _☐ 2 Day 1☐ 3 Day _☐ Combination 5*☐ All

* 3 of these users may have checked this after confusion with the wording.

10. Is the format used to report the stage and forecast ...

6☐ Easy to Read 1☐ Fairly Readable _☐ Hard to Read _☐ Lousey

AES WEATHER SUMMARY

11. Do you read the Weather Summary ...

7☐ Regularily _☐ Often _☐ Seldom _☐ Never

12. Do you find the Weather Summary useful ...

7☐ Very _☐ Often _☐ Occasionally _☐ Not

13. Do you receive any other regular Weather Forecasts?

4*☐ Yes 3☐ No * one user answered 'Yes, when required'

STAGE SUMMARY

14. Do you read the Stage Summary ...

5☐ Regularily 2☐ Often -☐ Seldom -☐ Never

15. Do you find the Stage Summary useful ...

3☐ Very 4☐ Often -☐ Occasionally -☐ Not

GENERAL COMMENTS

16. Is the forecast important in your Daily work?

Generally yes. One user will be using it less in future when hooked into local DCP.

17. Have you had any problems or complaints about the forecast this year? (use another page if necessary.

none

18. Any other observations or comments?

- high and low stage reports very useful.
- provides good background information.
- allows planning of maintenance to river facilities and pre-positioning of equipment.
- liked graph output.